

CLAIMS

What is claimed is:

- 1 1. A method comprising:
2 generating a phase compensation estimate for a data symbol of an
3 orthogonal frequency division multiplexed (OFDM) packet from pilot subcarriers
4 within the data symbol.
- 1 2. The method of claim 1 further comprising applying the phase
2 compensation estimate to subcarriers of the data symbol prior to demapping.
- 1 3. The method of claim 1 further comprising repeating generating and
2 applying for subsequent data symbols of the OFDM packet, and wherein the data
3 symbol is comprised of a plurality of symbol modulated subcarriers, at least some
4 of the symbol-modulated subcarriers of the plurality being the pilot subcarriers,
5 and wherein generating the phase compensation estimate comprises:
6 combining the pilot subcarriers in an observation vector former to generate
7 an observation vector; and
8 recursively filtering the observation vector to generate the phase
9 compensation estimate.
- 1 4. The method of claim 3 wherein repeating generating the phase
2 compensation estimate comprises:
3 combining the pilot subcarriers of a present data symbol to generate an
4 observation vector for the present data symbol; and
5 performing recursive filtering on the observation vector for the present
6 data symbol to generate the phase compensation estimate for the present data
7 symbol.
- 1 5. The method of claim 3 wherein repeating generating the phase
2 compensation estimates comprises:

3 combining the pilot subcarriers of a present data symbol to generate an
4 observation vector for the present data symbol; and
5 performing recursive filtering on the observation vector for the present
6 data symbol to generate a frequency offset estimate and the phase compensation
7 estimates for a next data symbol.

1 6. The method of claim 3 wherein recursively filtering comprises
2 performing extended Kalman filtering on the observation vector using a channel
3 estimate, an additive noise power estimate, a signal to noise ratio (SNR) estimate,
4 a priori information about a dynamic model of phase, and a phase noise power
5 value from a phase noise spectrum of transceiver oscillators.

1 7. The method of claim 5 wherein the channel estimate is generated from a
2 long training symbol of the OFDM packet, and wherein the additive noise power
3 estimate and the SNR estimate are generated from short training symbols of the
4 OFDM packet.

1 8. The method of claim 7 wherein the OFDM packet is comprised of a
2 plurality of sequential symbol modulated subcarriers, beginning with the short
3 training symbols modulated on a portion of the subcarriers followed by the long
4 training symbol and a plurality of data symbols, the data symbols containing at
5 least one known pilot subcarrier,
6 and wherein the channel estimate, the additive noise power estimate, the
7 SNR estimate, and the phase noise power value are used substantially for data
8 symbols of the OFDM packet.

1 9. The method of claim 3 wherein combining includes weighting the pilot
2 subcarriers based on fading gains for the pilot subcarriers prior to combining the
3 weighted subcarriers in generating the observation vector,
4 and wherein the method further comprises generating a channel estimate
5 from long training symbols of the OFDM packet, and wherein weighting includes
6 applying weights to pilot subcarriers, the weights being complex conjugates of the

7 fading gains of the pilot subcarriers, the fading gains being determined from the
8 channel estimate.

1 10. The method of claim 5 wherein recursively filtering comprises:
2 subtracting a predicted observation vector from the observation vector to
3 generate a residual vector;
4 multiplying the residual vector by a gain matrix to generate a residual gain
5 vector;
6 adding the residual gain vector to a linear prediction vector to generate an
7 estimate vector; and
8 extracting a frequency offset estimate and the phase compensation estimate
9 for the data symbol from the estimate vector.

1 11. The method of claim 10 wherein the estimate vector is a multi-
2 dimensional vector comprised of the frequency offset estimate and the phase
3 compensation estimate, and wherein the phase compensation estimate is applied to
4 a data symbol subsequent to performing a Fast Fourier Transform (FFT) on the
5 data symbol.

1 12. The method of claim 10 wherein the estimate vector is a multi-
2 dimensional vector comprised of a frequency offset estimate and the phase
3 compensation estimate, and wherein the method further comprises rotating a
4 phase of a serial symbol stream comprising the data symbol prior to performing a
5 Fast Fourier Transform on the data symbol.

1 13. The method of claim 2 further comprising:
2 performing a Fast Fourier Transform (FFT) on the plurality of parallel
3 groups of time-domain samples that represent the data symbol to generate
4 frequency domain symbol modulated subcarriers prior to applying the phase
5 compensation estimate;
6 separating the pilot subcarriers from data subcarriers of the frequency
7 domain symbol modulated subcarriers for use in generating the phase
8 compensation estimate; and

9 demapping the data symbol after applying the phase compensation
10 estimate to generate at least a portion of a decoded bit stream.

1 14. The method of claim 2 wherein the pilot subcarriers are comprised of
2 modulated pilot symbols having known training values and modulated on a
3 predetermined portion of subcarriers of the plurality.

1 15. A phase tracking unit comprising:
2 an observation vector former to weight and combine pilot subcarriers of a
3 data symbol of an orthogonal frequency division multiplexed (OFDM) packet to
4 generate an observation vector; and
5 a recursive filter to recursively filter the observation vector to generate a
6 phase compensation estimate for the data symbol, the recursive filter using a
7 channel estimate, an additive noise power estimate, a signal to noise ratio (SNR),
8 and a phase noise value estimate to perform the recursive filtering.

1 16. The phase tracking unit of claim 15 wherein the observation vector
2 former includes a weighting element to weight the pilot subcarriers based on
3 fading gains for the pilot subcarriers.

1 17. The phase tracking unit of claim 16 wherein the weighting element
2 receives the channel estimate generated from long training symbols of the OFDM
3 packet, and wherein the weighting element applies weights to pilot subcarriers, the
4 weights being complex conjugates of the fading gains, the fading gains being
5 determined from the channel estimate.

1 18. The phase tracking unit of claim 15 wherein the recursive filter
2 performs recursive filtering to generate phase compensation estimates for a
3 present data symbol of the OFDM packet.

1 19. The phase tracking unit of claim 18 wherein the observation vector
2 former further combines the pilot subcarriers of the present data symbol to
3 generate an observation vector for the present data symbol; and

4 the recursive filter recursively filters the observation vector for the present
5 data symbol to generate the phase compensation estimate for the present data
6 symbol.

1 20. The phase tracking unit of claim 19 wherein the recursive filter
2 subtracts a predicted observation vector from the observation vector to generate a
3 residual vector, multiplies the residual vector by a gain matrix to generate a
4 residual gain vector, adds the residual gain vector to a linear prediction vector to
5 generate an estimate vector and extracts the phase compensation estimate for the
6 data symbol from the estimate vector.

1 21. The phase tracking unit of claim 20 wherein the estimate vector is a
2 multi-dimensional vector comprised of frequency offset and the phase
3 compensation estimates, and
4 wherein extracting includes extracting the phase compensation estimate for
5 a data symbol from the estimate vector, and
6 wherein the phase compensator applies the phase compensation estimate to
7 the data symbol subsequent to performing a Fast Fourier Transform on the data
8 symbol.

1 22. An orthogonal frequency division multiplexed (OFDM) receiver
2 system comprising:
3 a dipole antenna to receive signals that include an OFDM packet;
4 an RF receive unit to convert the OFDM packet to a stream of symbols;
5 a data symbol-processing unit to perform a Fast Fourier Transform (FFT)
6 on the stream of symbols to generate a decoded bit stream;
7 a phase tracking unit to generate phase compensation estimates; and
8 a phase compensator to phase compensate subcarriers of a data symbol of
9 the OFDM packet after performing the FFT based on the phase compensation
10 estimate.

1 23. The system of claim 22 wherein the phase compensator includes:
2 an observation vector former to combine pilot subcarriers to generate an
3 observation vector; and
4 a recursive filter to recursively filter the observation vector to generate a
5 frequency offset and the phase compensation estimates for phase compensating
6 the data symbol.

1 24. The system of claim 23 wherein the observation vector former includes
2 a weighting element to weight the pilot subcarriers based on fading gains for the
3 pilot subcarriers prior to combining the weighted subcarriers in generating the
4 observation vector.

1 25. The system of claim 24 further comprising a long training symbol
2 processing element to generate a channel estimate from a long training symbol of
3 the OFDM packet, and wherein the weighting element applies weights to pilot
4 subcarriers, the weights being complex conjugates of the fading gains of the pilot
5 subcarriers, the fading gains being determined from the channel estimate.

1 26. The system of claim 23 wherein the recursive filter is an extended
2 Kalman filter and uses a channel estimate, an additive noise power estimate, a
3 signal to noise ratio (SNR) estimate, a priori information about a dynamic mode of
4 phase, and a phase noise power value from a phase noise spectrum of transceiver
5 oscillators to generate the phase compensation estimate.

1 27. The system of claim 26 further comprising:
2 a long training symbol processing element to generate the channel
3 estimate from a long training symbol of the OFDM packet; and
4 a short training symbol processing element to generate the additive noise
5 power estimate and the SNR estimate from short training symbols of the OFDM
6 packet,
7 and wherein the channel estimate, the additive noise power estimate, the
8 SNR estimate and the phase noise power value are used for subsequent data
9 symbols of the OFDM packet.

1 28. An article comprising a storage medium having stored thereon
2 instructions, that when executed by a computing platform, result in:
3 generating a phase compensation estimate for a data symbol of an
4 orthogonal frequency division multiplexed (OFDM) packet from pilot subcarriers
5 within the data symbol; and
6 applying the phase compensation estimate to subcarriers of the data
7 symbol prior to demapping.

1 29. The article of claim 28 wherein the instructions, when executed by the
2 computing platform, further result in repeating generating and applying for
3 subsequent data symbols of the OFDM packet, and wherein the data symbol is
4 comprised of a plurality of symbol modulated subcarriers, at least some of the
5 symbol-modulated subcarriers of the plurality being the pilot subcarriers.

1 30. The article of claim 29 wherein generating the phase compensation
2 estimate results in:
3 combining the pilot subcarriers in an observation vector former to generate
4 an observation vector; and
5 recursively filtering the observation vector to generate the phase
6 compensation estimate,
7 and wherein repeating generating the phase compensation estimate results
8 in:
9 combining the pilot subcarriers of a present data symbol to generate an
10 observation vector for the present data symbol; and
11 performing recursive filtering on the observation vector for the present
12 data symbol to generate the phase compensation estimate for the present data
13 symbol.